

# 2.4

## Trends, Interpolation, and Extrapolation



Have you ever heard people say that the price of a comic book was only 10¢ when they were young? Or that their allowance was \$2 a week? Over the years, the prices of most items have increased. You can analyse these trends and use them to make predictions.

### Tools

- TI-83 Plus or TI-84 graphing calculator
- grid paper

### Technology Tip

Enter negative values with the **(-)** key rather than the **-** key.

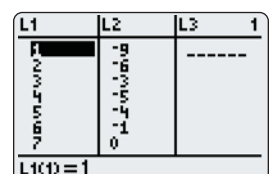
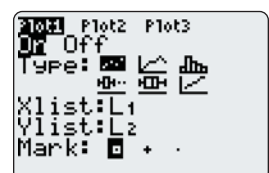
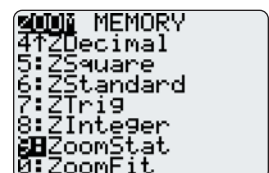
## Investigate

### How can you use trends to make predictions?

For a science project, Audrey recorded the minimum temperatures in her backyard for the first 10 days in March.


Day	1	2	3	4	5	6	7	8	9	10
Minimum Temperature (°C)	-9	-6	-3	-5	-4	-1	0	-1	2	3

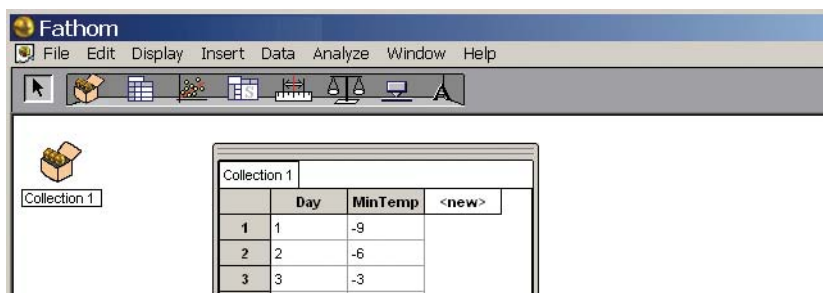
#### Method 1: Use a Graphing Calculator

- First, clear the calculator's lists:
  - Press **2nd** **[MEM]** to display the **MEMORY** menu.
  - Move the cursor down to **4:ClrAllLists**, and press **ENTER** twice.
- To start entering the data, press **STAT**, and select **1:Edit**.
- Enter the days into list **L1**, pressing **ENTER** after each entry. Then, enter the minimum temperatures into list **L2**.
 
- Set the calculator to display a scatter plot:
  - Press **2nd** **[STATPLOT]** to display the **STAT PLOTS** menu.
  - Select **1:Plot1** to display the settings for Plot1.
  - Select **ON** if it is not already highlighted.
  - Scroll down to **Type** and select the scatter plot symbol.
  - Xlist** should be set to **L1**. If a different list is shown, scroll down to **Xlist:** and enter **L1**. Similarly, **Ylist** should be set to **L2**.
  - Then, press **ZOOM** and select **9:ZoomStat**.


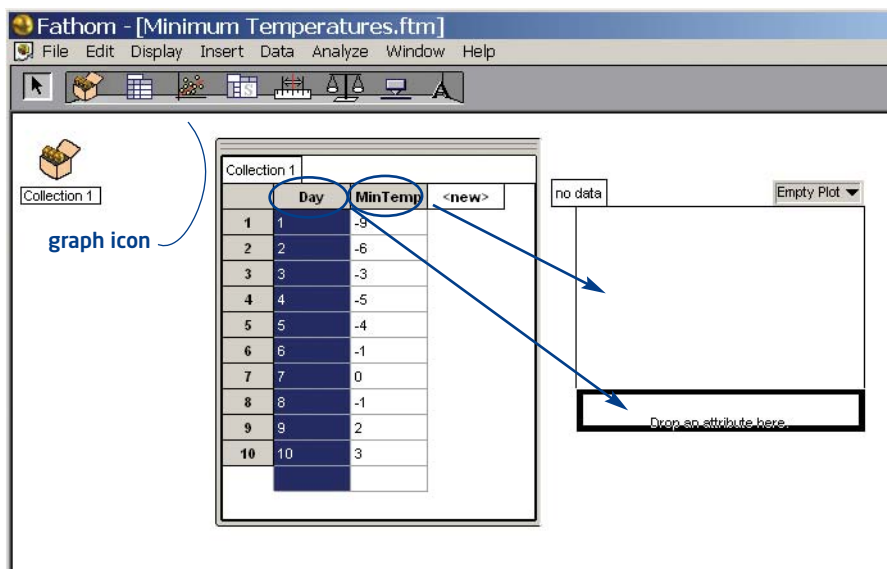
5. What does the horizontal axis of the scatter plot graph represent?  
What does the vertical axis represent?
6. Copy the scatter plot onto a sheet of graph paper. Label your graph completely.
7. Describe any trend you see in the temperatures on your graph.
8. **Reflect** Can you use a trend in the data to predict the minimum temperatures on March 11 and 12? Explain. Describe how you could estimate what the minimum temperature was on February 26.

#### Method 2: Use *Fathom™*

1. Click on the case table icon and drag it onto the desktop. 
2. Click on <new> at the top of the first column. Enter the heading “Day,” then press ENTER. Enter the heading “MinTemp” in the second column. Then, enter the data in the appropriate cells.

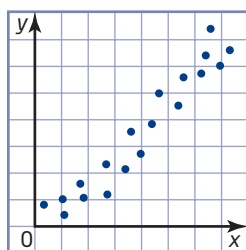


3. Click on the graph icon and drag it onto the desktop.  
Drag the “Day” heading to the horizontal axis.  
Then, drag the “MinTemp” heading to the vertical axis.  
You will see a scatter plot in the graph window.

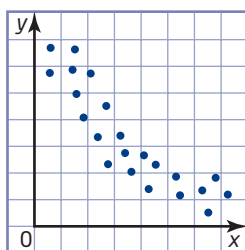


- What does the horizontal axis of the scatter plot represent? What does the vertical axis represent?
- Print the scatter plot. Then, add a title and proper labels to the axes on the printout.
- Describe any trend you see in the temperatures on your graph.
- Reflect** Can you use a trend in the data to predict the minimum temperatures on March 11 and 12? Explain. Describe how you could estimate what the minimum temperature was on February 26.

Graphs can help you recognize trends in a set of data. If you find a trend, you can use it to predict values of the variables.



upward trend



downward trend

### Literacy Connections

A fiscal year is a 12-month period used for accounting. The federal government and many businesses have a fiscal year that ends on March 31.

### Did You Know?

Severe acute respiratory syndrome (SARS) is a serious illness caused by a virus. An outbreak of SARS spread from China to North America, South America, and Europe in the spring of 2003. However, this outbreak was contained, and only a few isolated cases have appeared since.

### Example Use a Graph to Make Predictions

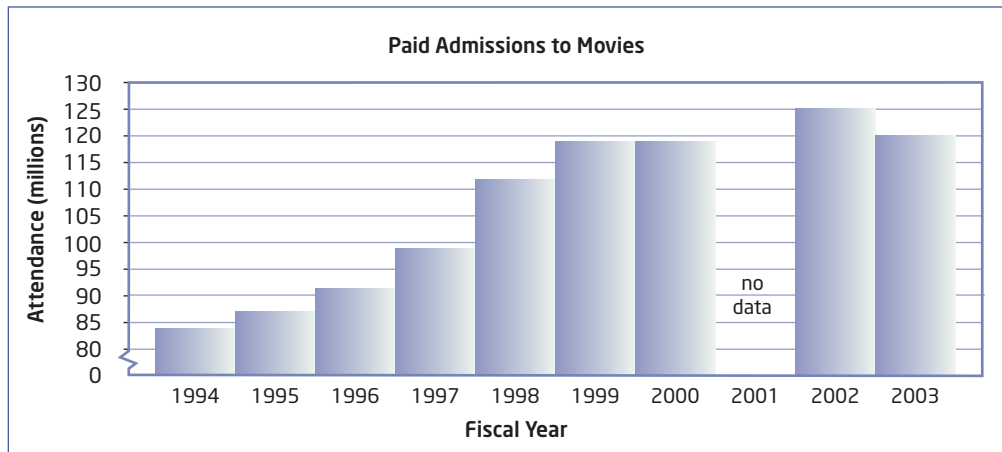
This table shows the number of paid admissions to movies in Canada for 12-month periods (fiscal years) ending on March 31.

Fiscal Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Attendance (millions)	83.8	87.3	91.3	99.1	111.6	119.3	119.3	no data	125.4	119.6

- Graph the data.
- Describe any trends in movie attendance from 1994 to 2004.
- Statistics Canada did not survey movie attendance for the period from April 2001 to March 2002. Estimate the movie attendance during this period.
- Predict the number of paid admissions to movies in Canada for the 12-month period ending in March 2006.
- The SARS outbreak in Canada occurred in the spring and summer of 2003. Would you change your prediction for 2005–2006 based on this additional information?

## Solution

- a) The movie admissions are given for 1-year intervals. A bar graph is a good way to display data for intervals.



Adapted from Statistics Canada, "Movie theatres and drive-ins: data tables," Catalogue 87F0009XIE, 2003/2004, 2002/2003, 2000/2001, and from Statistics Canada, Motion Picture Theatres Survey, various years.

- b) The attendance at movies increased by almost half from 1994 to 2000, but after 2000 there was little increase overall.
- c) You can **interpolate** an estimate of attendance at movies in the 2001–2002 period. A reasonable estimate is the mean of the numbers for 2000–2001 and 2002–2003, or about 122 million.
- d) You can **extrapolate** the trend in the data. Since there was only a small overall increase since 2000, a reasonable estimate for the 2005–2006 period is 120 million paid admissions.
- e) During the SARS outbreak, many people avoided crowds, especially in Toronto and Vancouver. The SARS outbreak likely caused a drop in movie attendance during the 2003–2004 period. So, the number of paid admissions during this period may not reflect the overall trend in movie attendance. If you leave out this outlier, then a reasonable prediction is that movie attendance will increase at the same rate as it did from 2000 to 2003. This trend gives an estimate of about 131 million paid admissions in the 2005–2006 period.

### interpolate

- estimate a value between two measurements in a set of data

### extrapolate

- estimate a value beyond the range of a set of data



## Key Concepts

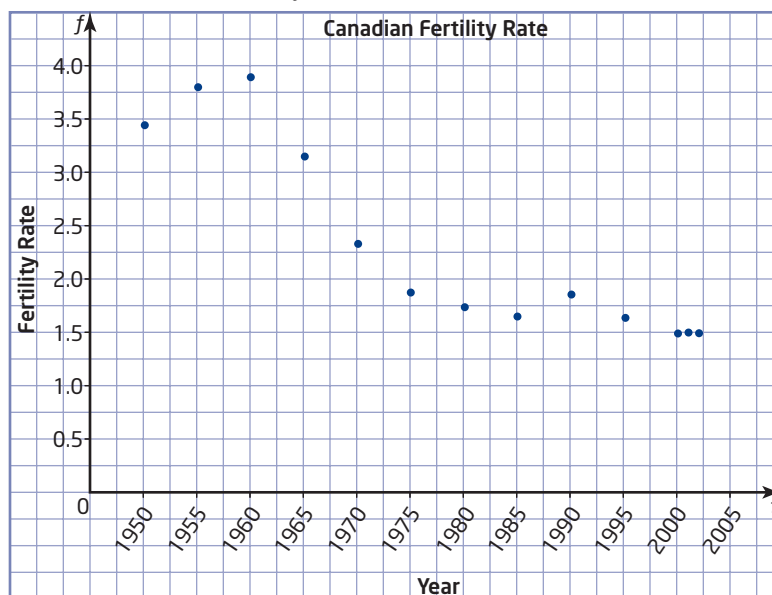
- A pattern in the graph of a set of data often indicates a trend.
- You can interpolate values between those in a set of data.
- You can extrapolate trends to predict values outside the range of a set of data.

## Communicate Your Understanding

- C1** Amy collected the following data on the sales of cell phones at her store. What type of graph should she use to display these data? Explain.

Year	2000	2001	2002	2003	2004	2005
Number Sold	2451	3010	3559	4925	4388	6052

- C2** The national fertility rate is the mean number of children born of women between the ages of 15 and 49 in Canada. This graph shows Canadian fertility rates since 1950.



### Did You Know?

National surveys by Statistics Canada require processing huge amounts of data. Often, the results of these surveys are not available until several years after the data were collected.

Adapted from Statistics Canada, Vital Statistics, Birth Database, various years

A newspaper reporter predicted, “If the trend continues, there will be no children born in 2030.”

- Has the reporter interpreted the graph correctly? Explain.
- What fertility rate would you predict for 2030? Explain how you made your estimate.

## Practise

For help with questions 1 and 2, see the Example.

- This table shows the mean monthly rent for a two-bedroom apartment in Guelph, Ontario, from 1996 to 2003.

Year	1996	1997	1998	1999	2000	2001	2002	2003
Rent (\$)	658	678	686	702	736	764	801	823

Adapted from CMHC Rental Market Reports, 1996–2003

- Make a bar graph of the data.
  - Describe the trend in rents.
  - Predict the mean rent for a two-bedroom apartment in Guelph in 2010.
- This table lists the estimated population of the world over the last 1000 years.

Year	1000	1250	1500	1750	1800	1850	1900	1950	2000
Population (millions)	310	400	500	790	980	1260	1650	2520	6060

- Make a scatter plot of the data.
- Describe the trend in world population growth.
- The United Nations predicts that the world population will stabilize at about 10 billion people around the year 2200. Does this prediction follow the trend shown in your graph? Explain.

## Connect and Apply

- This table shows the height of a bean plant during the first 2 weeks after it germinated.

Day	1	2	3	4	5	6	7
Height (cm)	0.8	2.4	4.9	6.8	8.5	10.5	12.9
Day	8	9	10	11	12	13	14
Height (cm)	15.0	16.9	18.6	20.7	22.5	24.7	26.8

- Make a scatter plot of the data.
  - Describe the growth trend of the bean plant during the 2 weeks.
  - Predict what will happen to the trend in future weeks. Explain your reasoning.
- This table shows the approximate mean retail price for 4 L of milk in southern Ontario since 1980.

Year	1980	1985	1990	1995	2000	2005
Price (\$)	1.87	2.85	3.30	3.56	3.82	4.70

- Graph the data.
- Describe the trend in milk prices.
- Estimate the cost of 4 L of milk in 1998.
- Predict when the price of 4 L of milk will reach \$6.00. What assumption did you make for this prediction?



5. This table summarizes the results of a survey of charitable donations by Canadians.

Age Group	Donor Rate (%)	Mean Amount per Donor (\$)
15–19	58	114
20–24	70	122
25–34	77	229
35–44	85	242
45–54	83	338
55–64	81	316
65–74	80	294
75+	72	330

- Make a bar graph of the data for the donor rates of the age groups. Describe the trend in this graph.
  - Make a bar graph of the data for mean donations by the age groups. Describe the trend in this graph.
  - Compare the trends in the two graphs.
6. This table summarizes data about Internet use in Canada.

Households Using the Internet (%)			
Year	Canada	Ontario	Saskatchewan
1998	22.6	25.5	18.2
1999	28.7	32.0	23.6
2000	40.1	44.1	32.5
2001	48.7	53.4	40.2
2002	51.4	57.7	46.0
2003	54.5	59.7	50.6

Adapted from Statistics Canada CANSIM Database, Table 358-0002, [http://estat.statcan.ca/cgi-win/CNSMCGI.EXE?CANSIMFILE=EStat\English\CII\\_1\\_E.htm](http://estat.statcan.ca/cgi-win/CNSMCGI.EXE?CANSIMFILE=EStat\English\CII_1_E.htm), November 2005

- Use a graph to compare the trend in Internet use in Canada with the trends in Ontario and Saskatchewan.
- Statistics Canada stopped this survey of Internet use after 2003. Estimate the percent of Canadian households that used the Internet in 2005. List any assumptions that you make.





7. The table shows the number of music singles, cassettes, and CDs sold in Canada between 1998 and 2004.

Sales of Recorded Music in Canada (millions of units)			
Year	Singles	Cassettes	CDs
1998	0.9	8.4	57.7
1999	0.8	5.7	58.4
2000	0.5	2.8	57.3
2001	0.5	1.4	54.0
2002	0.6	1.0	50.9
2003	0.8	0.3	49.0
2004	0.5	< 0.1	51.3

- Use graphs to help you describe the trends in the sales of each type of recording.
- Predict the sales of each type of recording in 2005.
- Use data from the Internet to check if your predictions were correct. Did any of the trends change in 2005?



Go to  
[www.mcgrawhill.ca/links/principles9](http://www.mcgrawhill.ca/links/principles9) and follow the links to learn more about the sales of recordings in Canada.

### Achievement Check

8. This table shows the time it takes a skateboarder to reach the bottom of a ramp when starting from various points along the ramp.

Initial Height (m)	Descent Time (s)
2.0	1.4
2.7	1.9
3.4	2.5
3.8	2.7
4.0	2.8
4.5	2.2
4.7	3.0
5.0	3.1

- Identify the independent variable and the dependent variable. Explain your reasoning.
- Make a scatter plot of the data.
- Describe the relationship between the variables.
- Identify any outliers. Explain whether you would include any of these outliers in the data set.
- Estimate the time it would take the skateboarder to reach the bottom of the ramp from a starting height of 3.6 m. Explain how you made your estimate.



## Making Connections

To earn a highschool diploma, you must do 40 h of volunteer community service. See your guidance teacher for details.



Go to [www.mcgrawhill.ca/links/principles9](http://www.mcgrawhill.ca/links/principles9) and follow the links to learn more information about *Limits to Growth*.

## Extend

9. This table shows some of the results of a survey of volunteer work by Canadians.

Age Group	Volunteer Rate		Mean Hours per Volunteer	
	Canada (%)	Ontario (%)	Canada	Ontario
15–24	29	28	130	150
25–34	24	19	131	149
35–44	30	29	153	163
45–54	30	31	158	151
55–64	28	28	181	157
65+	18	17	269	261

- Compare the relationship between age and volunteerism for Ontario residents with the relationship for all Canadians.
  - Which age group in Ontario has the greatest volunteer rate? Suggest why this age group volunteers more than others.
  - Describe the relationship between age and hours volunteered across Canada. Suggest a reason for this relationship.
10. The Club of Rome is a group of scientists, teachers, economists, and others who study world issues. In 1972, this group published a book called *Limits to Growth*. Use the Internet or a library to find one of the predictions made in this book. Describe the prediction. Discuss whether it is correct and how it relates to the topics in this section.
11. **Math Contest** At noon a group of boys and girl are in the cafeteria. When 15 girls leave, the ratio of boys to girls becomes 2:1. Then, 45 boys leave. There are now 5 girls for each boy. The number of girls in the group at noon was
- 29
  - 40
  - 43
  - 50
12. **Math Contest** Find the greatest number of Saturdays that can occur in the first 100 days of a year. Justify your answer.